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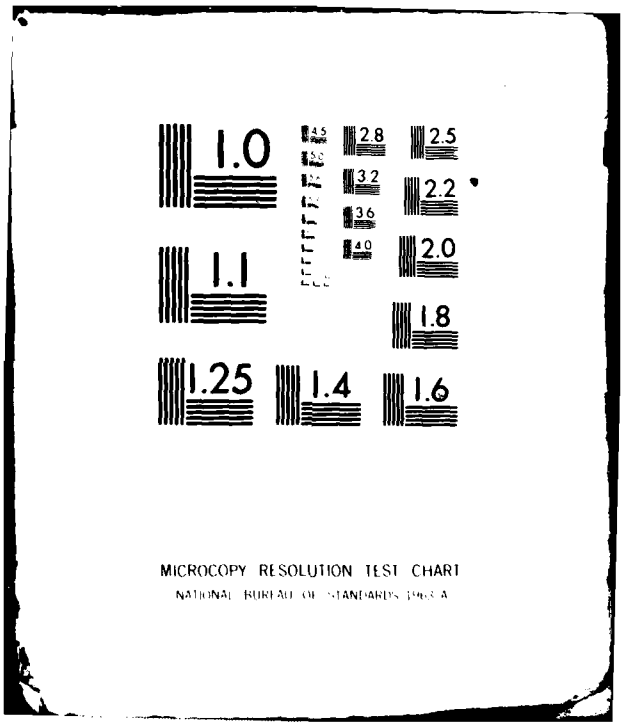
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SECOND INTERNATIONAL CONFERENCE ON SUPERCONDUCTING INTERFERENCE DEVICES AND THIRD WORKSHOP ON BIOMAGNETISM

J. R. NEIGHBOURS

6 November 1980

UNITED STATES OF AMERICA

(9) Conference Report

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This report covers the conferences on superconducting quantum interference devices and biomagnetism held in West Berlin on 6-9 May 1980. Subjects discussed were junction physics, junction and circuit noise, fabrication of junctions and circuits, high and low frequency applications, and applications. Ten invited and 62 contributed papers were presented at the SQUID conference.

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SECOND INTERNATIONAL CONFERENCE ON SUPERCONDUCTING QUANTUM INTERFERENCE DEVICES AND THIRD WORKSHOP ON BIOMAGNETISM

The beleaguered city of West Berlin, where the wall is a central fact of life, was the site of the Second International Conference on Superconducting Quantum Interference Devices (SQUIDS) and the Third Workshop on Biomagnetism which were held on 6-9 May 1980. There were approximately 198 attendees from 21 countries, with the host country represented by 64, the US by 28, and France, Italy, the UK, and Finland by about 15 scientists each. Other countries represented by over 5 scientists were Denmark, Switzerland, The Netherlands, Japan and Sweden. China, Mexico, Brazil, Australia, Yugoslavia, Bulgaria and Canada were also represented. Although there is considerable SQUID activity in the USSR, no papers were submitted by scientists from that country.

The SQUID conference extended over 4 days with no parallel sessions. During the conference 10 invited and about 52 contributed papers were presented along with 10 post-deadline papers. Of the 10 invited papers, 6 were from the US and 2 were from Denmark. These figures show a growth in size compared to the first SQUID meeting also held in West Berlin, on 5-8 Oct 1976 (ESN 31-2: 64 [1977]). At that first conference there were approximately 130 attendees from 11 countries, and the conference included 9 invited and 45 contributed papers, all presented over 4 days with no parallel sessions.

The third workshop on biomagnetism extended over 3 days with no parallel sessions. It included 7 invited and 27 contributed papers along with 7 post-deadline papers. It is not discussed further in this report except for a listing of the papers.

Support for the conference and the workshop was furnished by the European Physical Society, The Physikalisch-Technische Bundesanstalt (PTB), The Senate of Berlin, and the Siemans Company. The PTB is the national institute for research in physics and technology for the Federal Republic of Germany, similar to the US National Bureau of Standards. Formerly called the Physikalisch-Technische Reichsanstalt (PTR), the institute was founded in Berlin in 1887 and the present PTB occupies the same site. After World War II a part of the PTB was transferred to Braunschweig where approximately 1300 people now are employed compared to the 190 who work in Berlin.

Both conference and workshop were held in the Reichstag Building, which has been extensively repaired and modernized since the end of the war. For those who attended the conference, a considerable amount of travel was necessary because the Reichstag Building is located some distance from what is now the center of West Berlin. The excellent bus service to the Reichstag Building could be utilized or, if one preferred, one could walk. I enjoyed a pleasant stroll with J. Zimmerman (National Bureau of Standards, Boulder, CO) through

the park (tiergarten) one afternoon until rain forced us to engage one of the ubiquitous Mercedes taxis.

The SQUID conference included sessions on junction physics, junction and circuit noise, junction and circuit fabrication, high-frequency applications, and low-frequency applications. A majority of the invited papers and most of the contributed papers were from the US, which would seem to indicate that US research is quite active in the field. Because the proceedings will be published as a complete volume, no attempt is made here to give a comprehensive survey. Only various features and highlights are pointed out.

Following the usual European procedure, the conference was formally opened by H. D. Hahlbohm of the PTB. After welcoming the attendees, Hahlbohm noted that because of the large number of contributed papers, the program committee had reduced the time alloted to each paper in order to allow all of the papers to be fitted into the 4-day program. He also noted that the Josephson effect was one of the most important scientific discoveries of our era and that the ambience of the SQUID conference was turning more toward that of a Josephson junction conference.

Considerable time was given to high-frequency applications of superconducting devices. In an invited paper Professor N. F. Pedersen (Technical Univ. Lyngby, Denmark) highlighted some of the possible uses of superconducting devices as electronic components. This colorful individual, who was dressed in bib-overalls, noted that noise in superconducting-insulator-superconductor (SIS) mixers is now down to the quantum limit. For example, P. Richards, (Univ. of California, Berkeley) has achieved $2.6 \times 10^{-16} W(Hz)^{-1/2}$ in the 10-100 GHz range. Josephson mixers can be externally pumped up to 500 GHz, but are likely to lose in comparison with SISs since the former are noisier, have greater conversion loss, and require point contacts which are difficult to construct and maintain.

Pedersen remarked that since the last IC SQUID meeting, parametric amplifiers have been studied intensively by groups at Berkeley; Gothenburg, Sweden; Teddington, UK; and Lyngby, Denmark. An important problem with these devices is excessive noise rise which is sometimes observed to be greater than 100 K. In discussing this effect, Pedersen opined that: (1) the incoming, externally received 300 K radiation noise is not important; (2) a series reactance is detrimental; (3) the input coupling loss should be small and the input circuit should be matched to the transmission line impedance Z_o; (4) the junction resistance should be larger than Z_o. He said that he reached these conclusions after reading eight different treatments of the problem.

In a Josephson effect oscillator, according to Pedersen, the highest output achieved to date in the generation of electromagnetic

waves was 10^{-10}w, which would be suitable for use in a local oscillator or as a pump source. Although the emitted power of a single source is small, he believes that 2 dimensional arrays with reasonable powers might possibly be constructed. A 2 dimensional array of 100 x 100 junctions, each of output power of 10^{-11}w, could have a total output power in the milliwatt range.

As mixers Josephson junctions have been used up to 500 GHz, however, in Pedersen's opinion they are likely to loose in comparison to SIS mixers for the following reasons: (1) the Josephson mixers are noisier, (2) the Josephson mixers have a larger conversion loss than that found in SIS mixers, (3) point contacts are needed to construct the Josephson mixer devices if the user builds them rather than obtaining them from Bell or IBM. At present, in the 10-500 GHz range the Josephson mixers are not yet down to the quantum limit. Pedersen concluded by noting that the RF applications of the Josephson junctions are very active research subjects and the SIS mixer is promising enough that it may soon be used in radiotelescopes.

In other sessions devoted to technology, J. E. Zimmerman (NBS, Boulder, CO) presented his latest results on the Stirling engine as an alternative "cold" source to a liquid helium bath; and W. Gobau (Univ. of California, Berkeley) and W. Podney (Physical Dynamics Corp., La Jolla, CA) discussed geophysical measurements with SQUIDS. Some non-US-based work was represented in reports by R. Adams (Admiralty Compass Observatory, Slough, UK) and P. Mateew (Institute für FestKörperphysik III, Berlin).

Adams told about work on nuclear gyros and magnetometers that he and S. Potts (Admiralty Compass Observatory, Slough, UK) carried out in conjunction with J. C. Gallop and W. J. Radcliffe (National Physical Lab., Teddington, UK).

In the nuclear gyro, the precession of ^{3}He nucleii is detected by a SQUID through a flux transformer. With the equipment stationary, preliminary results give a maximum free precession time of about one second; indicating that the homogeneity of the trapped field is approximately 10^{-7} T/m. Since the flux density must be constant in order to attain long-time stability, changes in shape or size of the superconducting shield must be made small. At liquid helium temperatures, the authors claim that dimensional instability can be made to be the principal source of error and would result in a gyro drift rate of only 10^{-3} deg/hr.

Mateew discussed experiments by himself and H. Heidrich in which an optically transparent crystal is placed in the coil of a SQUID magnetometer. Chopped monochromatic light transmitted to the sample via a fiber optic induced changes in the magnetic state of the system which were lock-in detected. Results for GdS from approximately 2 K to 150 K and in small fields ($6x10^{-3}$T and $1x10^{-4}$T) show

that its magnetic susceptibility is a function of field. At both fields a peak occurs at approximately 60 K, with the susceptibility generally being higher and the peak more pronounced at the higher field. The apparatus can also be used to measure the time dependence of the induced change in susceptibility with a resolution of about 0.5 msec.

Some controversy arose over the work of Dr. T. D. Clark (Univ. of Sussex, UK) and Dr. A. Widom (Northeastern Univ., Boston, MA.). Their ideas on noise and tunneling were discussed in a special meeting but no definite conclusions were reached. Clark and Widom and their colleagues have submitted a paper on this subject to *NATURE*.

Many of the attendees at the conference and workshop took the opportunity to visit the West Berlin section of the PTB, which has a long tradition in cryogenics. L. Holborn and W. Wien performed thermometric measurements there at the turn of the century, and in 1913, W. Nernst installed a hydrogen liquifier. Later, in 1933, W. Meissner while working at the PTB first observed the effect which bears his name. Today, cryogenic work continues in SQUIDS, low-temperature thermometry, and biomagnetism.

For the biomagnetic activities, a facility consisting of a magnetically shielded room and ancillary space for both electronic equipment and subject preparation has been constructed. Somewhat over 7 feet (2.22m) on a side, the room has an interior volume of approximately 11 m^3. It consists of a cubic copper cabin in the center surrounded by 6 layers of λmu metal with a combined mass of 40,000 kg. The expected screening factor varies from 60 db near dc level to 100 db at one GHz. Sixteen data channels with a transmission rate of eight kHz are available in the shielded room and are connected to the exterior by a fiber-optic link. Not yet operational, this system is intended to be available for research projects performed in cooperation with guest scientists. The entire setup is contained in one large room about the size of a small basketball court and is complete with an overhead crane.

Although the level of activity at both the conference and the workshop was intense and the PTB is clearly an outstanding research institution, the ultimate ambience in West Berlin is depressing. Many of the people there are desperately afraid that the West will ultimately forget them. The East-West conflict was highlighted for me when one of the participants with whom I was having lunch left hurriedly in order to try to meet his mother from East Berlin, who he hoped would be allowed to pass through Checkpoint Charlie to visit him. I never learned whether they met. (J. R. NEIGHBOURS)

C-9-80

PROGRAM

SECOND INTERNATIONAL CONFERENCE ON SUPERCONDUCTING QUANTUM INTERFERENCE DEVICES

"PROGRESS IN PHYSICS OF JOSEPHSON JUNCTIONS"
H. Lübbig, Berlin, Germany (invited)

"NON-EQUILIBRIUM PHENOMENA IN JOSEPHSON JUNCTIONS"
P.E. Lindelof, Copenhagen, Denmark (invited)

"FLUCTUATION ANALYSIS"
J. Clarke, Berkeley, U.S.A. (invited)

JUNCTION PHYSICS

A 1 "STUDY OF A SPIN-GLASS PHASE TRANSITION BY THE DC JOSEPHSON EFFECT"
C. Van Haesendonck, L. Van den dries, Y. Bruynseraede and A. Gilabert

A 2 "CHARACTERIZATION OF NON-EQUILIBRIUM SUPERCONDUCTIVITY VIA THE JOSEPHSON EFFECT"
A. Gilabert, C. Vanneste, P. Sibillot and D. Ostrowsky

A 3 "JOSEPHSON EFFECT THROUGH LOCALLY LOWERED TUNNELING BARRIERS"
M. Russo

A 4 "VANADIUM-BASED JOSEPHSON JUNCTIONS"
A. Barone, M. Russo, A. Di Chiara and G. Peluso

A 5 "MEASUREMENT OF THE COSψ-AMPLITUDE OF NIOBIUM POINT CONTACTS CONTAINED IN A RF-SQUID"
S.N. Ernè, H. Luther and H.J. Scheer

A 6 "EFFECTS OF MAGNETIC FIELDS AND QUASI-PARTICLE CONDUCTANCE ON TRANSITION DYNAMICS IN DC SQUIDS"
E. Ben Jacob and Y. Imry

A 7 "AN ELECTRONIC ANALOGUE OF A HIGH FREQUENCY THEORY OF THE JOSEPHSON EFFECT"
D.G. Jablonski and J.R. Waldram

A 8 "MAGNETIC FIELD BEHAVIOR OF ZERO-FIELD STEPS IN LONG JOSEPHSON JUNCTIONS"
G. Costabile, A.M. Cucolo, S. Pace, R.D. Parmentier, B. Savo and R. Vaglio

A 9 "PROPERTIES OF COHERENT VORTEX MOTION IN Pb-Nb-Pb ION IMPLANT VARIABLE THICKNESS BRIDGES"
P. Crozat, G. Vernet and R. Adde

A 10 "SUPERCURRENT INTERFERENCE PATTERNS AND EXCESS CURRENTS IN JOSEPHSON JUNCTIONS"
P.W. Epperlein

A 11 "MEASUREMENT OF ORDER-PARAMETER VARIATIONS IN A SUPERCONDUCTING AL FILM"
J.A. Pals and J. Dobben

"FUNDAMENTALS OF SQUID APPLICATIONS"
R.P. Giffard, Stanford, U.S.A (invited)

"INSTRUMENTATION FOR BIOMEDICAL APPLICATIONS"
T. Katila, Helsinki, Finland (invited)

JUNCTION AND CIRCUIT NOISE

B 1 "EXPERIMENTAL STUDIES OF LOW FREQUENCY NOISE IN THE RF SQUID"
J.T. Anderson and B. Cabrera

B 2 "NOISE, SLEW RATE AND THE STABILITY OF AC-BIASED SQUID MAGNETOMETERS"
A.P. Long, R.J. Prance and T.D. Clark

"DESIGN AND CONSTRUCTION OF ULTRA LOW NOISE CRYOGENIC GaAs FET AMPLIFIERS FROM 0.4 TO 10 GHz"
M.W. Potts, A.P. Long, R.J. Prance, T.D. Clark and F. Goodall

"QUANTUM LIMITED AC-BIASED 430 MHz SQUID MAGNETOMETER"
R.J. Prance, A.P. Long, T.D. Clark, J.E. Mutton and A. Widom

B 3 "THE PLASMA RESONANCE IN THE RESPONSE OF A CAPACITIVELY SHUNTED JOSEPHSON JUNCTION"
T. Poorter and H. Tolner

B 4 "THERMODYNAMIC EQUILIBRIUM FLUCTUATIONS GENERATED BY A JOSEPHSON TUNNEL JUNCTION DESCRIBED BY THE WERTHAMER THEORY"
G. Brunk

B 5 "QUANTUM VERSUS THERMALLY EXCITED FLUXOID TRANSITIONS IN A SQUID RING"
J. Kurkijärvi

JUNCTION AND CIRCUIT FABRICATION

"JUNCTION AND CIRCUIT FABRICATION"
L.D. Jackel, Holmdel, U.S.A. (invited)

C 1 "FABRICATION AND CHARACTERIZATION OF THERMALLY RECYCLABLE SUBMICRON NIOBIUM-NIOBIUM JOSEPHSON JUNCTIONS"
G.M. Daalmans

C 2 "SUPERCONDUCTIVE TUNNELING THROUGH EDGE-GROWN BARRIERS"
G. Dousselin and J. Rosenblatt

C 3 "SOME PROPERTIES OF Nb_2O_5 THERMALLY GROWN TUNNEL BARRIERS IN Nb-Nb_2O_5-P_b(In) JOSEPHSON JUNCTIONS"
J.C. Villegier and G. Matheron

C 4 "REFRACTORY WEAK LINK JOSEPHSON DEVICES"
J.H. Claassen, E.J. Cukauska and M. Nisenoff

C 5 "FABRICATION AND CHARACTERIZATION OF THE FILM PARAMETERS IN ION-IMPLANT Nb BRIDGES WITH THICK Pb BANKS"
P. Crozat and R. Adde

C 6 "Nb WEAK LINKS FOR SQUID APPLICATIONS"
R.B. Laibowitz, A.N. Broers, R.F. Voss, S.E. Raider and J.M. Viggiano

C 7 "SIMPLE FABRICATION AND CHARACTERIZATION OF THIN-FILM NIOBIUM SQUIDS WORKING AT 4.2K"
D. Pascal

C 8 "ULTRA LOW NOISE DE SQUIDS"
R.F. Voss, R.B. Laibowitz, M.B. Ketchen and A.N. Broers

C 9 "DC SQUIDS FEBRICATED WITH NIOBIUM-NIOBIUM TUNNEL JUNCTIONS"
V.J. de Waal

HIGH FREQUENCY APPLICATIONS

"MICROWAVE APPLICATIONS OF SUPERCONDUCTING TUNNELING DEVICES"
N.F. Pedersen, Lungby, Denmark (invited)

D 1 "EXPERIMENTAL RESULTS OF THE MAGNETIC COUPLING"
Cui Guang-Ji, Meng Xiao-Fan, Guo Wei-Xin, Li Jia-Zhang and Tai Yuan-Tung

D 2 "MICROWAVE PROPERTIES OF LONG JOSEPHSON JUNCTIONS"
K. Yoshida, K. Hamasaki, F. Irie and M. Inoue

D 3 "THE SINGLY QUASI-DEGENERATE JOSEPHSON JUNCTION PARAMETRIC AMPLIFIER. DESIGN GUIDE-LINES."
O.H. Soerensen

D 4 "JOSEPHSON PARAMETRIC AMPLIFIER AS A PART OF A GRAVITY WAVE DETECTION SCHEME"
J. Kadlec

D 5 "VIDEO DETECTION OF mm-WAVE RADIATION USING SIS JOSEPHSON JUNCTION"
H.J. Hartfuß, K.H. Gundlach and J. Kadlec

"FABRICATION OF SMALL JOSEPHSON TUNNEL JUNCTION"
K.H. Gundlach, M. Zahn, K. Okuyama and H.J. Hartfuß

D 6 "DETECTION OF 1 mm RADIATION WITH SUBMICRON HIGH CURRENT DENSITY NIOBIUM-NIOBIUM JOSEPHSON JUNCTIONS"
G.M. Daalmans, Th. de Graauw, S. Lindholm and F. v. Vliet

D 7 "CHARACTERISTICS OF JOSEPHSON JUNCTION HARMONIC MIXERS WITH EVEN AND ODD HARMONIC NUMBERS"
K. Fujisawa, S. Kita, T. Hirosaki and K. Fujiie

D 8 "mm-WAVE DETECTION USING QUASIPARTICLE TUNNELING"
H.J. Hartfuß and K.H. Gundlach

D 9 "SIS QUASIPARTICLE MIXING WITH ANTENNA-COUPLED ARRAYS"
S. Rudner, M.J. Feldman, E. Kollberg and T. Claeson

D 10 "JOSEPHSON JUNCTION APPLICATIONS IN PLASMA PHYSICS"
B.T. Ulrich and M. Tutter

D 11 "JOSEPHSON RADIATION EMITTED FROM A MICROBRIDGE AT 9, 35 AND 69 GHz"
J. Mygind, N.F. Pedersen, O.H. Soerensen, B. Dueholm, T.F. Finnegan, J. Bindslev Hansen, M.T. Levinsen and P.R. Lindelof

D 12 "COHERENT RADIATION OF JOSEPHSON JUNCTION ARRAYS"
Yuan-Dong Dai and Y.H. Kao

D 13 "MICROWAVE GENERATION USING COHERENT ARRAYS OF JOSEPHSON JUNCTIONS"
A.K. Jain, P.M. Mankiewich, R. Ono, D.B. Schwartz, A.M. Kadin and J.E. Lukens

COMPUTERS AND CRYOELECTRONICS

"COMPUTERS AND CRYOELECTRONICS"
T. Van Duzer, Berkeley, A.S.A. (invited)

E 1 "RAMP-RATE DEPENDENCE OF TURN-ON DELAYS IN JOSEPHSON SWITCHING DEVICES"
R.L. Peterson

E 2 "JOSEPHSON FIELD EFFECT TRANSISTORS"
R.J. Prance and T.D. Clark

E 3 "TOLERANCES AND GAIN OF ASYMMETRIC JOSEPHSON JUNCTION INTERFEROMETER FOR AND GATES"
H. Beha

E 4 "DIRECT-COUPLED FOUR-JOSEPHSON JUNCTIONS LOGIC GATE"
S. Takada, S. Kosaka and H. Hayakawa

CRYOGENIC TECHNIQUES

"CRYOGENIC TECHNIQUES FOR SQUIDS"
J.E. Zimmerman, Boulder, U.S.A. (invited)

GEOPHYSICAL APPLICATIONS

"GEOPHYSICAL APPLICATIONS"
W.M. Goubau, Berkeley, U.S.A. (invited)

F 1 "THE DESIGN OF DEWAR SYSTEMS FOR GEOPHYSICAL SQUID MAGNETOMETERS"
B.R. Barnard

F 2 "USE OF SUPERCONDUCTIVE MAGNETIC GRADIOMETERS FOR MEASURING MAGNETIC EFFECTS OF GEOPHYSICAL ORIGIN"
W. Podney

LOW FREQUENCY APPLICATIONS

G 1 "APPLICATIONS OF SQUIDS TO NUCLEAR GYROS AND MAGNETOMETERS"
R. Adams, S.P. Potts, J.C. Gallop and W.J. Radcliffe

G 2 "APPLICATION OF THE SQUID-MAGNETOMETER FOR OPTOMAGNETIC INVESTIGATIONS"
H. Heidrich and P. Mateew

G 3 'OPTIMISING THE DESIGN OF THIN-FILM D.C. SQUID GRADIOMETERS"
C.M. Pegrum and G.B. Donaldson

G 4 "THE PRESSURE, TEMPERATURE, AND POWER DEPENDENCE OF STABLE CRYO-RESISTORS"
J.C. Macfarlane and H.C. Collins

G 5 "TOROIDAL SQUID WITH A NORMAL METAL FILTER"
T. Fujita

G 6 "BEHAVIOR OF THE DC IMPEDANCE OF AN RF-BIASED RESISTIVE SQUID"
D. Van Vechten, R.J. Soulen, Jr. and R.L. Peterson

G 7 "HIGHER HARMONICS IN THE JOSEPHSON EFFECT AND THE SPECTROSCOPY OF MACROSCOPICALLY QUANTISED AC-BIASED SQUID MAGNETOMETERS"
A. Widom, T.D. Clark, G. Megaloudis, R.J. Prance, A.P. Long and J.E. Mutton

"CLASSICAL TO MACROSCOPIC QUANTUM TRANSITION IN AC-BIASED SQUID MAGNETOMETERS"
A.P. Long, T.D. Clark, R.J. Prance, J.E. Mutton, A. Widom and A. Caldeira

G 8 "ANALYSIS OF THE REVERSIBLE MAGNETIZATION OF A RF SQUID CONTAINING A WEAK LINK WITH NON-SINUSOIDAL CURRENT PHASE RELATIONSHIP"
H. Lübbig

POST DEADLINE PAPERS

PD 1 "THE EFFECT OF MAGNETIC FIELD ON THE HEIGHT OF MICROWAVE-INDUCED STEP"
Wei Chong-De and Li Jia-Zhang

PD 2 "INPUT INDUCTANCE OF THE RF SQUID IN HYSTERETIC MODE"
S.S. Tinchev

PD 3 "THEORY OF JOSEPHSON JUNCTION MIXERS"
G.J. Ehnholm

PD 4 "LOW FREQUENCY NOISE IN SMALL-AREA TUNNEL JUNCTION DC SQUIDS"
M.B. Ketchen and C.C. Tsuei

PD 5 "HIGH RELIABILITY Pb-ALLOY JOSEPHSON JUNCTION FOR INTEGRATED CIRCUITS"
H.-C.W. Huang, S. Basavaiah, C.J. Kircher, E.P. Harris, M. Murakami, S. Kiepner and J.H. Greiner

PD 6 "THE CURRENT PHASE RELATION OF SUPERCONDUCTING BRIDGES"
Yao Xi-Xian

PD 7 "SUB-HARMONIC STEPS OF SUPERCONDUCTING BRIDGES"
Yao Xi-Xian

PD 8 "ON THE ϕ_{DC} - DEPENDENCE OF THE RF-SQUID-NOISE"
R. Cristiano, S.N. Ernè and H. Luther

PD 11 "EFFECTS OF MICROWAVE RADIATION OF GRANULAR AL MICROBRIDGES"
B. Dwir and G. Deutscher

PD 12 "MICROWAVE INDUCED HARMONIC AND SUBHARMONIC STEPS IN THE I-V CHARACTERISTICS OF CURRENT FED JOSEPHSON JUNCTIONS"
Y. Braiman, E. Ben Jacob and Y. Imry

THIRD WORKSHOP ON BIOMAGNETISM:

"FUNDAMENTALS OF SQUID APPLICATIONS"
R.P. Giffard, Stanford, U.S.A (invited)

"INSTRUMENTATION FOR BIOMEDICAL APPLICATIONS"
T. Katila, Helsinki, Finland (invited)

"MEDICAL SIGNIFICANCE OF THE MAGNETIC ACTIVITIES OF THE HUMAN BODY"
A.P. Freedman, Philadelphia, U.S.A. (invited)

"GENERATION OF MAGNETIC FIELDS BY THE HUMAN BODY"
R. Plonsey, Cleveland, U.S.A. (invited)

W 1 "SOURCES OF EVOKED NEUROMAGNETIC FIELDS"
D.E. Farrell, J.H. Tripp and D. Hess

W 2 "THEORY OF THE PR SEGMENT OF THE HUMAN MCG"
J.H. Tripp and D.E. Farrell

W 3 "BIOMAGNETIC FIELDS AND CELLULAR CURRENT FLOW"
J.H. Tripp

W 4 "NON-INVASIVE SQUID DIAGNOSIS OF LIVER IRON OVERLOAD"
D.E. Farrell, J.H. Tripp, P.E. Zanzucchi, J.W. Harris, G.M. Brittenham and W.A. Muir

W 5 "SUSCEPTOMETER FOR IN VIVO MEASUREMENTS OF IRON STORED IN HUMAN TISSUE"
C.M. Bastuscheck, D. Brenner, S.J. Williamson and L. Kaufman

W 6 "PROPOSAL FOR AN IMPROVEMENT OF NMR-IMAGING BY LOW-TEMPERATURE-SQUID-DETECTION TOWARDS MOLECULAR KINETIC MEASUREMENTS LOCALIZED TO A SMALL SUB-REGION OF THE SAMPLE"
W.H. Bergmann

"CARDIOMAGNETISM"
P. Karp, Kuopio, Finland (invited)

W 7 "ON THE RECORDING OF PHASE AND AMPLITUDE RELATIONSHIPS BETWEEN ELECTRICAL AND MAGNETICAL CARDIAC EVENTS"
I.R. Eghrari, J.P. von der Weid, P. Costa Ribeiro and O. Symko

W 8 "MEASUREMENT OF MAGNETOCARDIOGRAMS WITH SECOND-DERIVATIVE SQUID GRADIOMETER"
H. Ohmichi, M. Ibuka and K. Atsumi

W 9 "SIMULTANEOUS MEASUREMENT OF THE MAGNETIC HEART VECTOR COMPONENTS WITH UNIPOSITIONAL LEAD SYSTEM"
J. Lekkala and J. Malmivuo

W 10 "HIGH RESOLUTION CARDIOMAGNETISM"
D.E. Farrell and J.H. Tripp

W 11 "R AND T WAVES IN THE MCG AND ECG"
C.I.J.M. Stuart, S.B. Woods, A.C. Crawford, N.R. Thomas and K.B. Newbound

W 12 "PROPERTIES OF AN IDEAL MCG-RECORDING SYSTEM"
J. Malmivuo

W 13 "ENHANCEMENT OF MAGNETOCARDIOGRAMS BY APPLIED MAGNETIC FIELDS"
M.J. Peters, Z. Dunajski and L.C. van der Marel

"BIOMAGNETISM PRODUCED BY IONIC CURRENTS: NEUROMAGNETISM"
S.J. Williamson, New York, U.S.A. (invited)

W 14 "MAGNETORITINOGRAPHIC MEASUREMENTS"
K. Aittoniemi, M.-L. Järvinen, T. Katila and T. Varpula

W 15 "LOCALIZATION OF NEURAL GENERATORS UNDERLYING AUDITORY EVOKED MAGNETIC FIELDS OF THE HUMAN BRAIN"
K. Aittoniemi, R. Hari, M.-L. Järvinen, T. Katila and T. Varpula

W 16 "ESTIMATION OF THE MAGNETOENCEPHALOGRAM POWER SPECTRUM"
D.W. Hess

W 17 "MAPS OF THE MAGNETIC EVOKED FIELD"
D. Brenner, Y. Okada, E. Maclin, S.J. Williamson and L. Kaufman

W 18 "APPLICATION OF A SQUID TO MEASUREMENTS OF SOMATICALLY EVOKED FIELDS: TRANSIENT RESPONSES TO ELECTRICAL STIMULATION OF THE MEDIAN NERVE"
Y. Okada, L. Kaufman, D. Brenner and S.J. Williamson

W 19 "SENSITIVITY DISTRIBUTION IN MAGNETOENCEPHALOGRAPHY"
J. Malmivuo

INSTRUMENTATION

W 20 "INSTALLATION OF A BIOMAGNETIC MEASUREMENT FACILITY IN A HOSPITAL ENVIRONMENT: A FIRST STUDY"
C. Bercy, D. Duret, P. Karp and D. Teszner

W 21 "THICK-WALLED CONDUCTING SHIELD IN BIOMAGNETIC EXPERIMENTS"
J. Malmivuo, P. Heinonen, M. Tuomola and J. Lekkala

W 22 "AN ALUMINIUM SHIELDED ROOM FOR BIOMAGNETIC MEASUREMENTS"
G. Stroink, B. Brown, B. Blackford and M. Horacek

W 23 "A SUPERCONDUCTING HELMET FOR MAGNETOENCEPHALOGRAPHY WITH A SQUID"
H.E. Hoenig and C. Gassinger

W 24 "AN INTEGRATED SYSTEM FOR MEASUREMENT OF THE MCG AND CARDIAC OUTPUT"
M.C. Leifer, G.C. Griffin, E.J. Iufer, W.F. Fairbank and D.C. Harrison

W 25 "BIOMAGNETIC MEASUREMENTS IN UNSHIELDED, NORMALLY NOISY ENVIRONMENTS: PRESENT STATUS OF ART"
S. Barbanera, P. Carelli, G.L. Romani, F. Bordoni and I. Modena

"MAGNETOPNEUMOGRAPHY"
S.E. Robinson, Philadelphia, U.S.A. (invited)

W 26 "PRACTICAL MAGNETOPNEUMOGRAPHY USING FLUXGATE MAGNETOMETERS"
K. Aittoniemi, K. Kalliomäki, T. Katila and T. Varpula

W 27 "MAGNETIC FIELD MEASUREMENTS ON LUNGS: A COMPARISON BETWEEN TWO METHODS"
G. Stroink and D. Dahn

POST DEADLINE PAPERS

W29P "ANALYTIC METHODS FOR MAGNETOPNEUMOGRAPHY"
S.E. Robinson and A.P. Freedman

W30P "EVALUATION OF MAGNETOPNEUMOGRAPHY FOR ASSESSING THORACIC ACCUMULATION OF WELDING FUME PARTICULATE"
A.P. Freedman and S.E. Robinson

W31P "LOCALIZED-FIELD MAGNETOPNEUMOGRAPHIC MEASUREMENTS OF COAL WORKERS AND OF FREEZE-DRIED LUNGS"
A.P. Freedman, S.E. Robinson and F.H.Y. Green

W32P "CONSTRUCTION AND PERFORMANCE OF THE OTANIEMI MAGNETICALLY SHIELDED ROOM"
V.O. Kelhä

W33P "SOME REMARKS ON THE BERLIN MAGNETIC SHIELDED ROOM"
S.N. Ernè

W34P "CONSTRUCTION OF THE BERLIN MAGNETICAL SHIELDED ROOM"
L. Borek

W35P "MAGNETOCARDIOGRAPHIC STUDY OF SOME HUMAN CARDIAC ELECTRO-PHYSIOLOGICAL PHENOMENA: PRELIMINARY OBSERVATIONS"
S. Barbanera, P. Carelli, R. Leoni, G.L. Romani, F. Bordoni, I. Modena, R. Fenici and P. Zeppilli


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